A cross-country analysis of intervention policies during the early phase of COVID-19 using a multi-objective optimization approach

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ABSTRACT

Since COVID-19 emerged in early 2020, policymakers have been devising optimal non-pharmaceutical intervention policies that minimize the incidence without incurring high implementation costs. In this research, we propose a mathematical model considering isolation, hospitalization, and imported cases to explain the early stages of the COVID-19 pandemic. Parameter estimation is performed in two steps: (1) we search global solutions using the Improved Multi-Operator Differential Evolutionary method (IMODE), and (2) a stochastic process, the Markov Chain Monte Carlo process (MCMC), gives us the probability distribution of each parameter using the initial value from IMODE. In addition, a multi-objective optimization method is formulated to analyze the trade-off between minimizing the number of daily incidence cases and reducing the economic costs of intervention policies. The obtained Pareto-optimal curve is compared with the country-specific policy, which is quantified from the estimated parameters. Then, we use quantitative economic evaluation methods on the optimal curve to assess the effectiveness of the implemented policy. The multiple optimal solutions offer trade-off solutions, which the policymaker can use in decision-making.

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